APPENDIX L
Marine Survey and Assessment for Potential Mitigation Sites
Miami Harbor General Re-evaluation Report
Miami Harbor, Miami-Dade County, Florida

FINAL

MARINE SURVEY AND ASSESSMENT
FOR POTENTIAL MITIGATION SITES
MIAMI HARBOR GENERAL RE-EVALUATION REPORT
MIAMI HARBOR
MIAMI-DADE COUNTY, FLORIDA

October 2002

Prepared for:
U.S. Army Corps of Engineers
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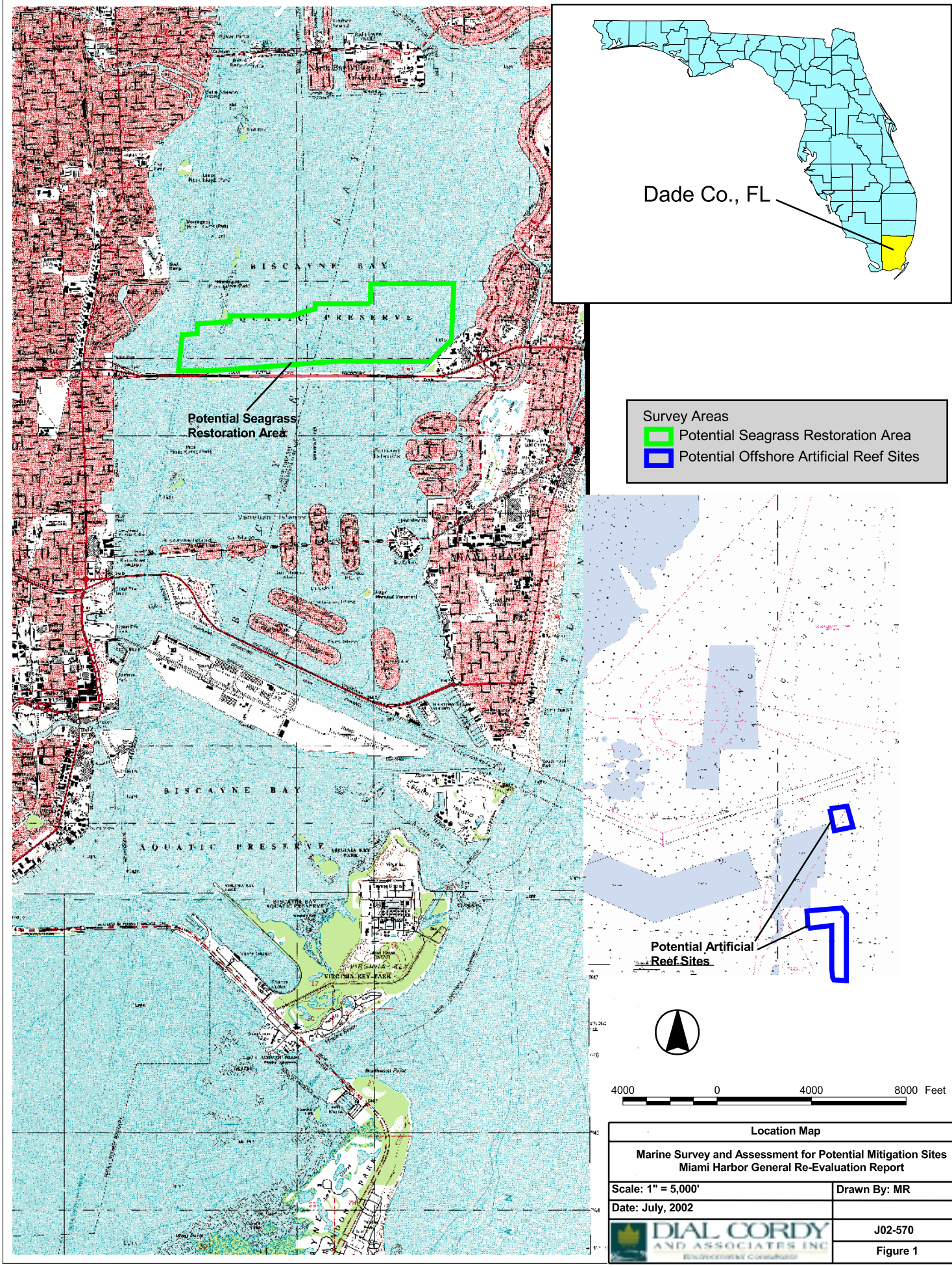
1.0 INTRODUCTION

Dial Cordy and Associates Inc. (DC&A) was contracted by the Jacksonville District Army Corps of Engineers (Corps) under contract DACW17-99-D-0057, W.O. 0029 to provide a marine benthic and bathymetric survey and assessment of potential mitigation sites in the vicinity of Miami Harbor, Miami-Dade County, Florida (Figure 1). This work is being done in conjunction with the Miami Harbor General Re-evaluation Report.

1.1 Project Purpose

North Biscayne Bay has undergone extensive man-made changes since the early 20th century. In particular, construction of the Julia Tuttle Causeway created depressions from dredge and fill operations associated with construction of islands to support the causeway. The Corps has identified potential seagrass mitigation sites in North Biscayne Bay near the Julia Tuttle Causeway based on review of a previous study conducted for Miami-Dade County Department of Environmental Resources Management (DERM) (Coastal Technology Corporation 1989). The Corps has an interest in potentially utilizing these borrow areas left from this construction as seagrass mitigation areas. To further define site conditions within and adjacent to these areas, field studies including seagrass mapping, biological characterization, bathymetric survey, and surficial sediment sampling were conducted. The results of these surveys are summarized in this report.

In addition to the potential seagrass mitigation areas, two potential offshore mitigation reef sites were identified and investigated for future use in artificial reef creation. The Corps will use this information to help plan mitigation measures in relation to planned Port of Miami Federal Channel improvement efforts. This information will also be incorporated by the Corps and utilized as baseline biological information during the planning and permitting process.



Location Map	
Marine Survey and Assessment for Potential Mitigation Sites Miami Harbor General Re-Evaluation Report	
Scale: 1" = 5,000'	Drawn By: MR
Date: July, 2002	
DIAL CORDY AND ASSOCIATES INC	J02-570
	Figure 1

2.0 TECHNICAL APPROACH

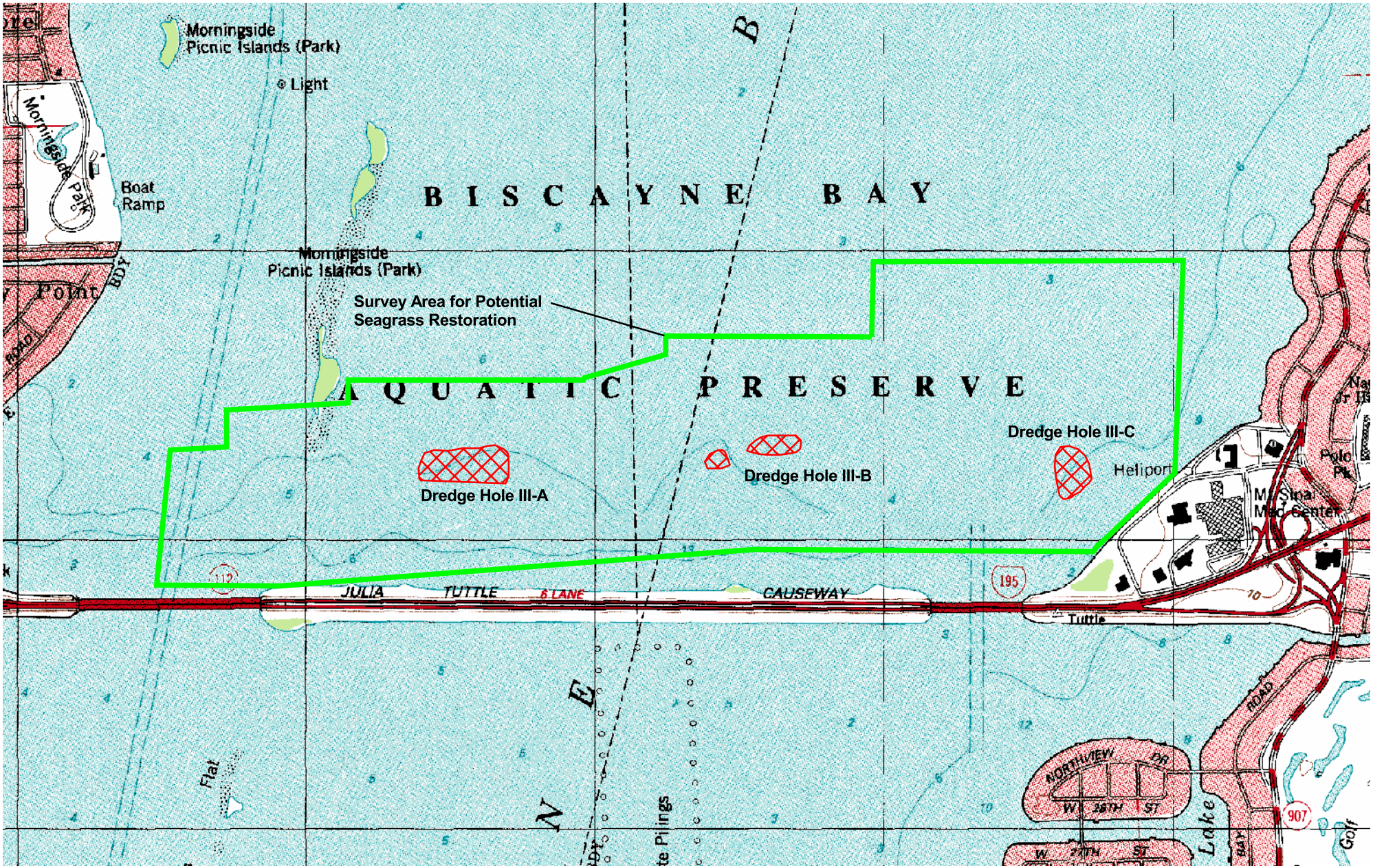
A description of the methods utilized to document marine resources within the study area is described below. Surveys were conducted June 4-6, 2002.

2.1 Location of Survey

The potential seagrass mitigation areas surveyed included a previously used borrow area located just north of the Julia Tuttle Causeway in north Biscayne Bay (Figure 2). This borrow area was evaluated previously for use as potential habitat restoration (Coastal Technology Corporation 1989). Coastal Technology (1989) referred to the borrow areas located here as Unit III, and identified three potential areas for restoration that they labeled Area III-A, Area III-B, and Area III-C. Survey locations were supplied to DC&A by the Corps based on review of this document. The offshore areas surveyed for potential artificial reef creation are adjacent to Miami-Dade County Artificial Reef Sites A and B (Figure 3). The potential artificial reef creation sites were chosen for their proximity to currently permitted artificial reef creation sites and also water depths within the survey areas.

2.2 Bathymetric Survey

To define the extent of the borrow areas left from previous dredging efforts, a bathymetric survey was performed. Bathymetric data was collected using an Odum Hydrotrac® echosounder and data recorded electronically. A tide gauge was deployed throughout the survey period and vertical control was obtained from a marker set by the project surveyor.



1500 0 1500 3000 Feet

Seagrass Survey Area	
Marine Survey and Assessment for Potential Mitigation Sites Miami Harbor General Re-Evaluation Report	
Scale: 1" = 1,500'	Drawn By: MR
Date: July, 2002	
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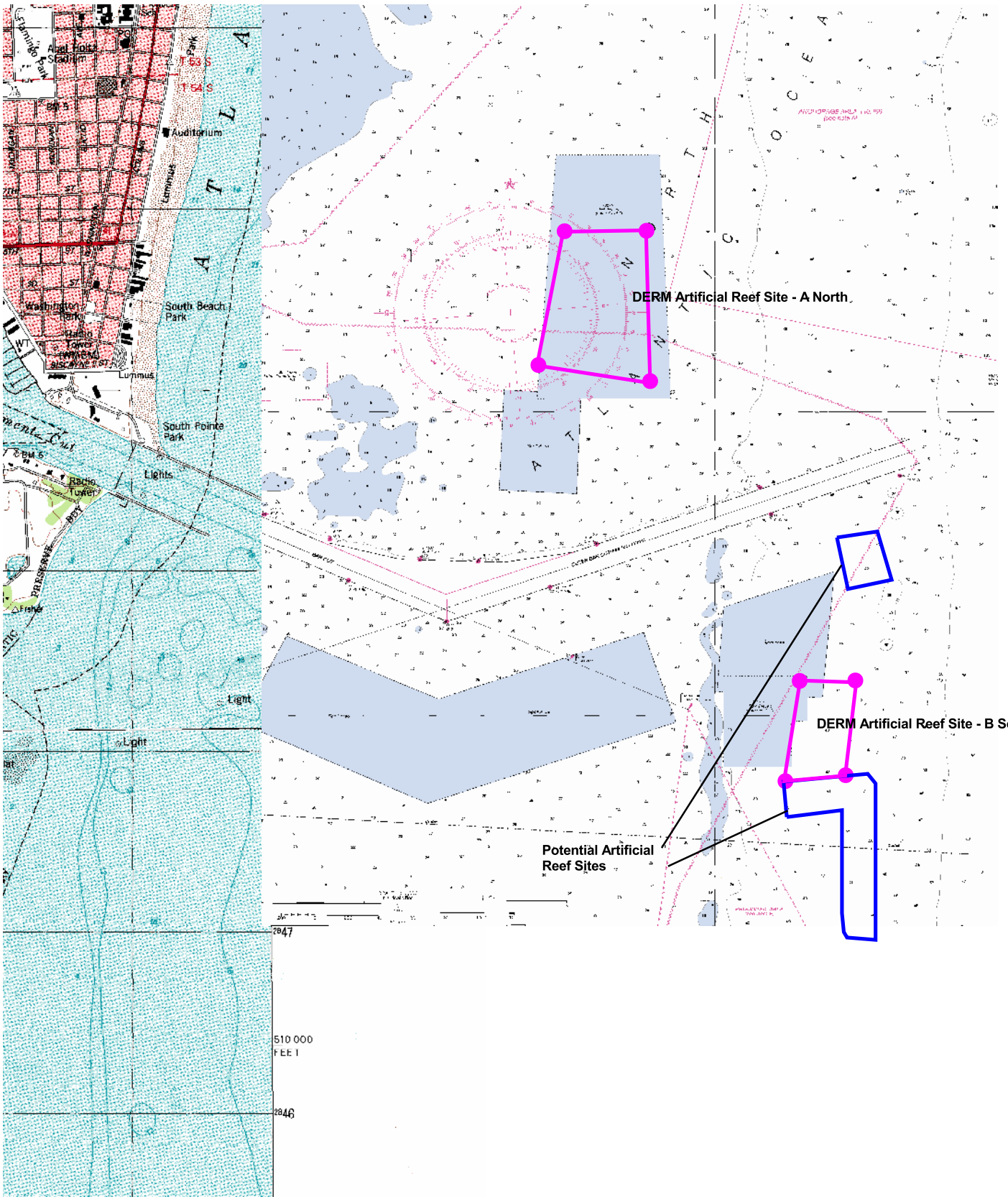
	Figure 2



Potential Offshore Artificial Reef Sites

Permitted Artificial Reef Site Corners

2500 0 2500 5000 Feet

Potential and Permitted Offshore Artificial Reef Sites	
Marine Survey and Assessment for Potential Mitigation Sites Miami Harbor General Re-Evaluation Report	
Scale: 1" = 2,500'	Drawn By: MR
Date: July, 2002	
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	Figure 3

Positioning was determined by using a Trimble Differential Geographic Positioning System (DGPS) receiver coupled with Coastal Oceanographic's HYPACK®Max navigational software. The system was used during the survey for vessel guidance, data logging, and real time vessel track plotting. Data were then used to create a mosaic for analysis and interpretation.

2.3 Video Survey Methodology

The beginning and end of each transect was located using a Trimble DGPS. Once the beginning of each transect was located, an underwater video camera was lowered to within one-foot of the bottom and towed along the transect line using Hypack® Max software to maintain the vessel's course and also superimpose location coordinates onto the video. The underwater video camera was viewed onboard while being towed and the occurrence of seagrass, rocks, sand, algae, and hardbottom were documented. The documentation was used later when reviewing the video to denote the resource description and DGPS location. For mapping purposes, the following resource type classification system was used (Table 1)

Table 1 Resource Type Classification System

Bottom Resources	Description
Thalassia testudinum	Turtle grass was the dominant resource
Halodule wrightii	Shoal grass was the dominant resource
Syringodium filiforme	Manatee grass was the dominant resource
Mixed grasses	A mixture of *Thalassia testudinum, Syringodium filiforme,* and/or *Halodule wrightii* was the dominant resource
Sand	Sand was the dominant resource
Sand/Algae	Marine algae was the dominant resource
Rock/Algae	A mixture of rock and algae were the dominant resource
Artificial Reef	Artificial Reef material previously placed
Hardbottom/Reef	Living hardbottom (offshore survey site)

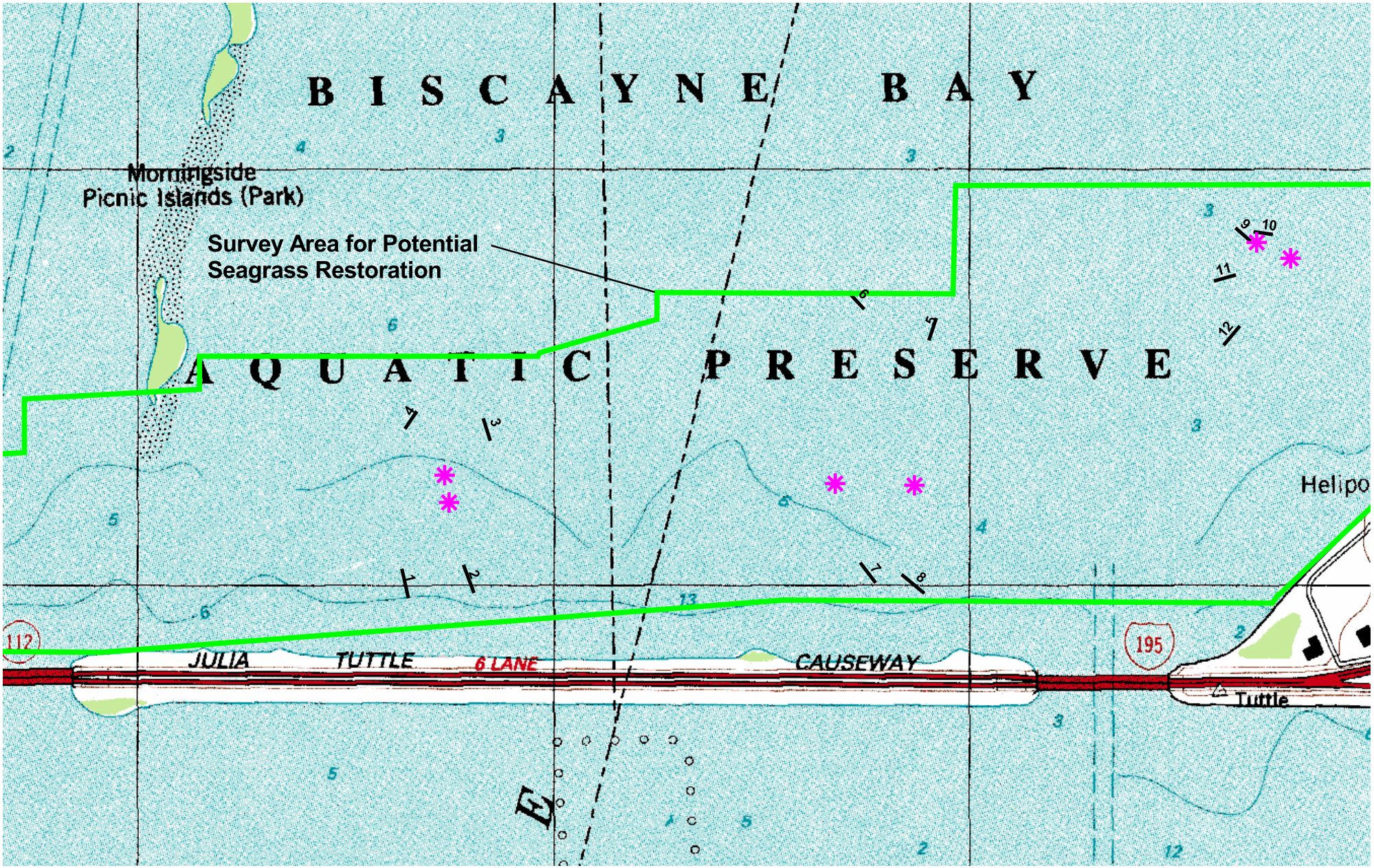
Following compilation of resource type distribution, a spreadsheet was developed incorporating the resource classification system. Resource types were superimposed over an aerial map using ArcView® GIS.

2.4 Biological Data Collection

2.4.1 Seagrass Mitigation Areas

To obtain biological data regarding the location, occurrence, abundance, and density of marine seagrass, a snorkel point intercept survey was performed. For each transect, the average percent (percent of 16, 25 x 25 cm sub-units within a 1 m^2 quadrat that contains at least one seagrass shoot) was estimated in 1 m^2 quadrats at four intervals along each transect line (Fonseca, et al. 1998; Virnstein 1995; Braun-Blanquet 1965). Transect lines were 60 m in length and randomly selected along the north and south sides of the borrow areas. Locations of quadrat sampling are shown in Figure 4. Specific data recorded within each 1 m^2 quadrat for each marine seagrass species present included the number of sub-units containing at least one shoot, an average cover abundance score (Braun-Blanquet 1965), a description of the substrate type, and any other observations considered useful. Field data were entered into a spreadsheet for analysis.

Diver characterizations using digital video were also conducted within the deeper extents of the borrow areas. Previous artificial reef sites and other dominant biological communities were documented and recorded. Surficial sediment samples were also collected during these diver surveys and archived for later use.



Potential Seagrass Restoration Area
Surficial Sediment Sample Locations
Seagrass Quadrat Transects

1000 0 1000 2000 Feet

Seagrass Transects and Sediment Sampling Locations	
Marine Survey and Assessment for Potential Mitigation Sites Miami Harbor General Re-Evaluation Report	
Scale: 1" = 1,000'	Drawn By: MR
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	Figure 4

2.4.2 Offshore Artificial Reef Areas

Following completion of the towed video survey, areas of potential hardbottom occurrence were located and divers deployed to document the biological communities present and the extent of coverage of each. Digital video and still photography were used to document the dominant biological communities.

2.5 Analysis and Interpretation

Community types were classified by the dominant resource type within the area. For example, if one or two rocks were identified within an area composed predominately of *H. wrightii*, then *H. wrightii* was considered the dominant resource type. The towed video and seagrass transect data were incorporated into resource maps. Frequency of occurrence, abundance, and density were calculated from the quadrat data based on Braun-Blanquet (1965) methodology.

Bathymetry data collected during the survey was post processed and a contour map produced for the survey area. Bathymetry lines shown are based on a 5-foot contour referenced to NAVD 88. Depths within the survey area ranged from 5 feet to greater than 30 feet (NAVD 88).

3.0 RESULTS

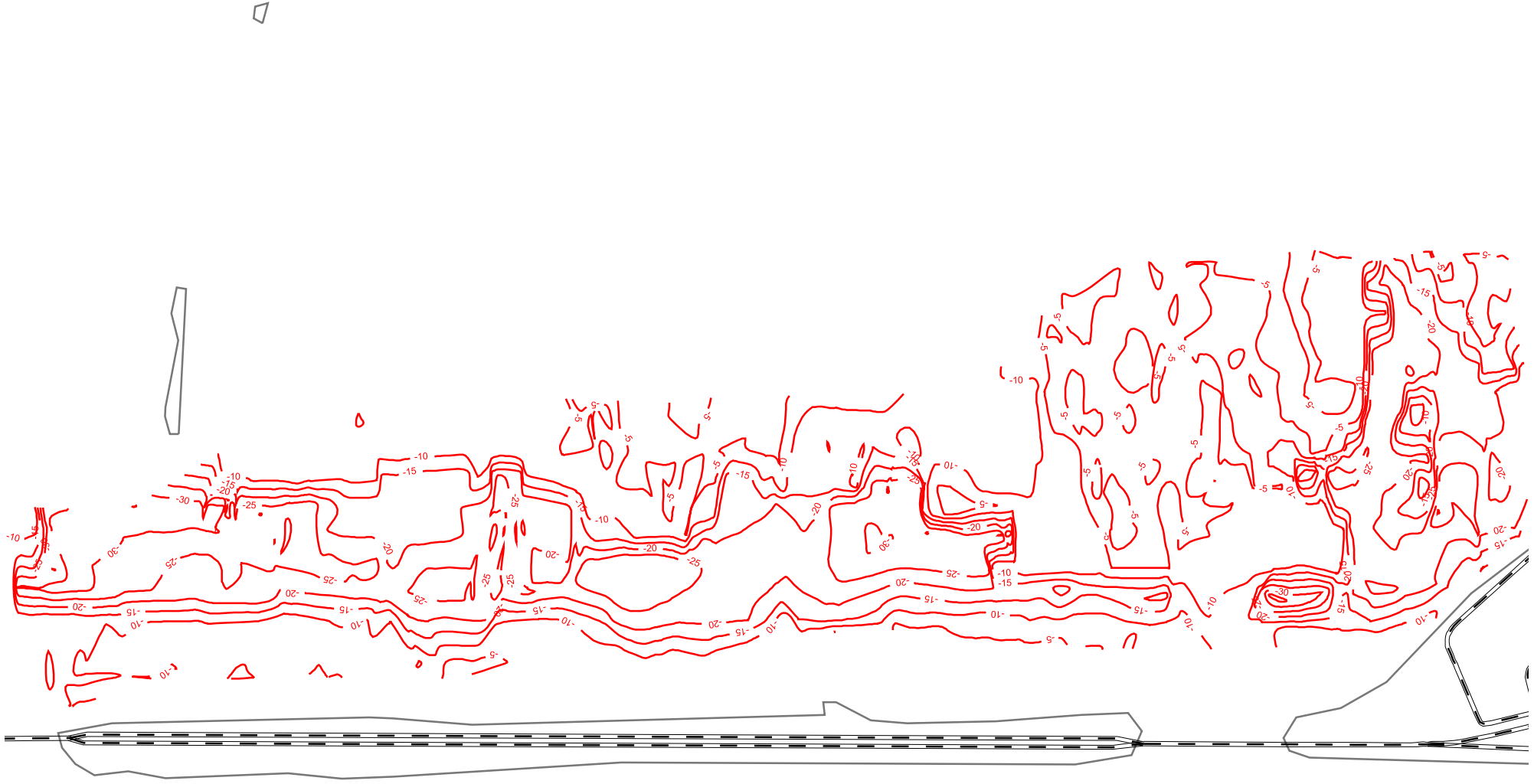
3.1 Seagrass Mitigation Sites-Bathymetry and Marine Resource Characterization

The occurrence and distribution patterns of marine habitats within the survey area surrounding the potential seagrass mitigation areas are described below.

3.1.1 Bathymetry

This survey was conducted based on information gained from a previous report on potential seagrass mitigation sites in northern Biscayne Bay (Coastal Technology Corporation 1989). Based on this previous study, it was believed that three distinct relatively shallow (8 to 10 feet in depth) borrow areas existed within this area. The present survey revealed different conditions. Bathymetric survey contours and depth characterizations within the study area are shown in Figures 5 and 6 and reveal that there two borrow areas in the study area. The first is a very large hole of over 100 acres in size that dominates the area. Depths within this area range from approximately 5 feet at the edge to over 30 feet (NAVD 88) in the deeper recesses of the borrow area. The second borrow area also is much larger in overall area (approx. 40 acres) than previously documented. The borrow areas identified by Coastal Technology Corporation were actually smaller holes within these larger borrow areas.

The majority of the area surveyed had depths greater than 5 feet (NAVD 88), while the areas of mixed grasses occurred in areas where water depths were shallower (approximately 5 feet NAVD 88). In general, the more homogeneous beds of *S. filiforme* occurred in the deeper water farther from the islands created for the Julia Tuttle Causeway, while the shallower areas nearest to the islands, along the southern side of the survey area, had shallower depths and more diverse mixed grass assemblages (Figure 5).



Bathymetry Contours (5 ft. interval)

1

Roads

Shoreline

1000 0 1000 2000 Feet

Bathymetric Contours for Seagrass Restoration Area	
Marine Survey and Assessment for Potential Mitigation Sites Miami Harbor General Re-Evaluation Report	
Scale: 1" = 1,000'	Drawn By: MR
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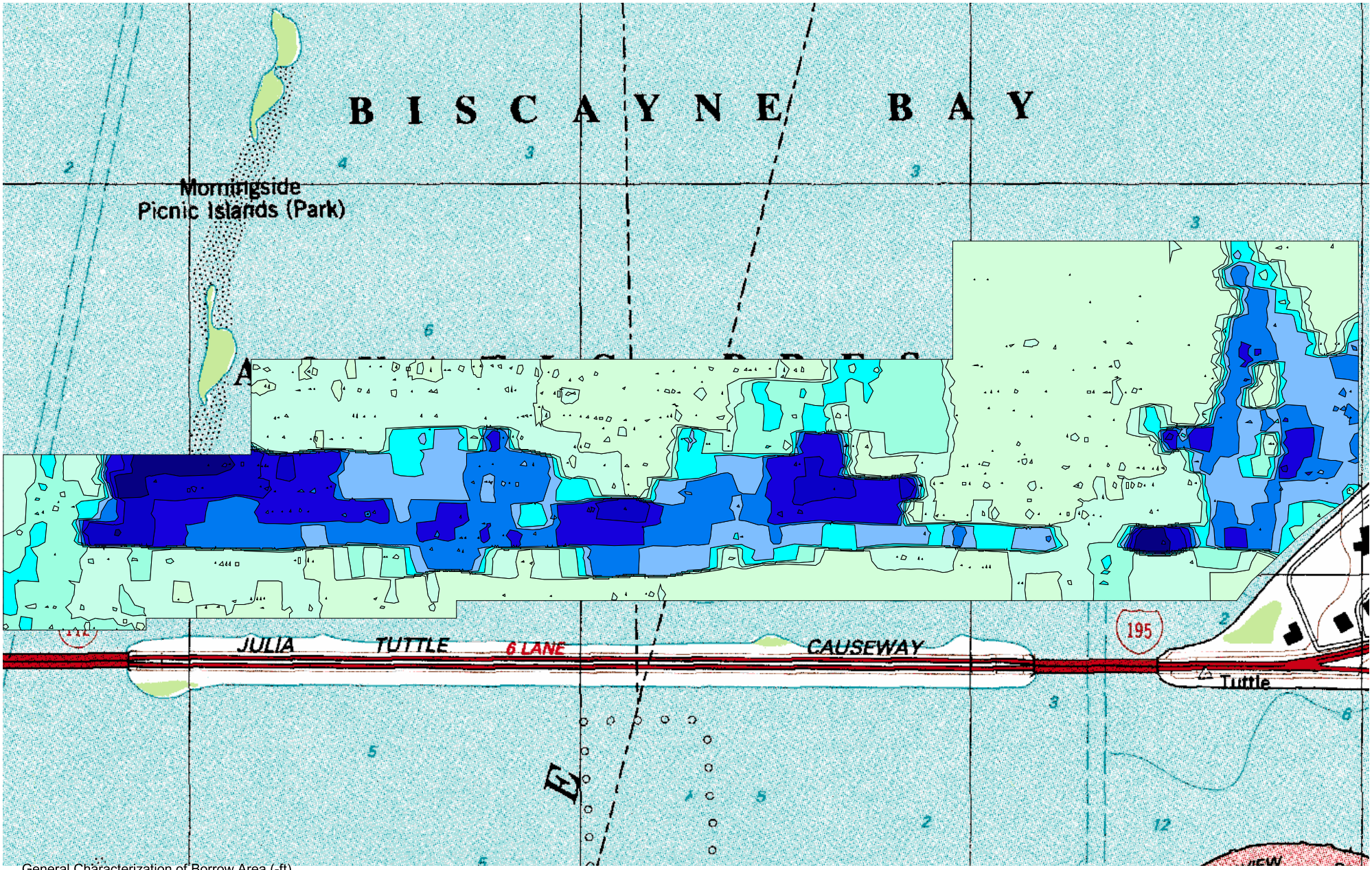
	Figure 5



Borrow Area - Depth Characterization	
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	Figure 6

3.1.2 Marine Resources

3.1.2.1 Live Bottom Habitat

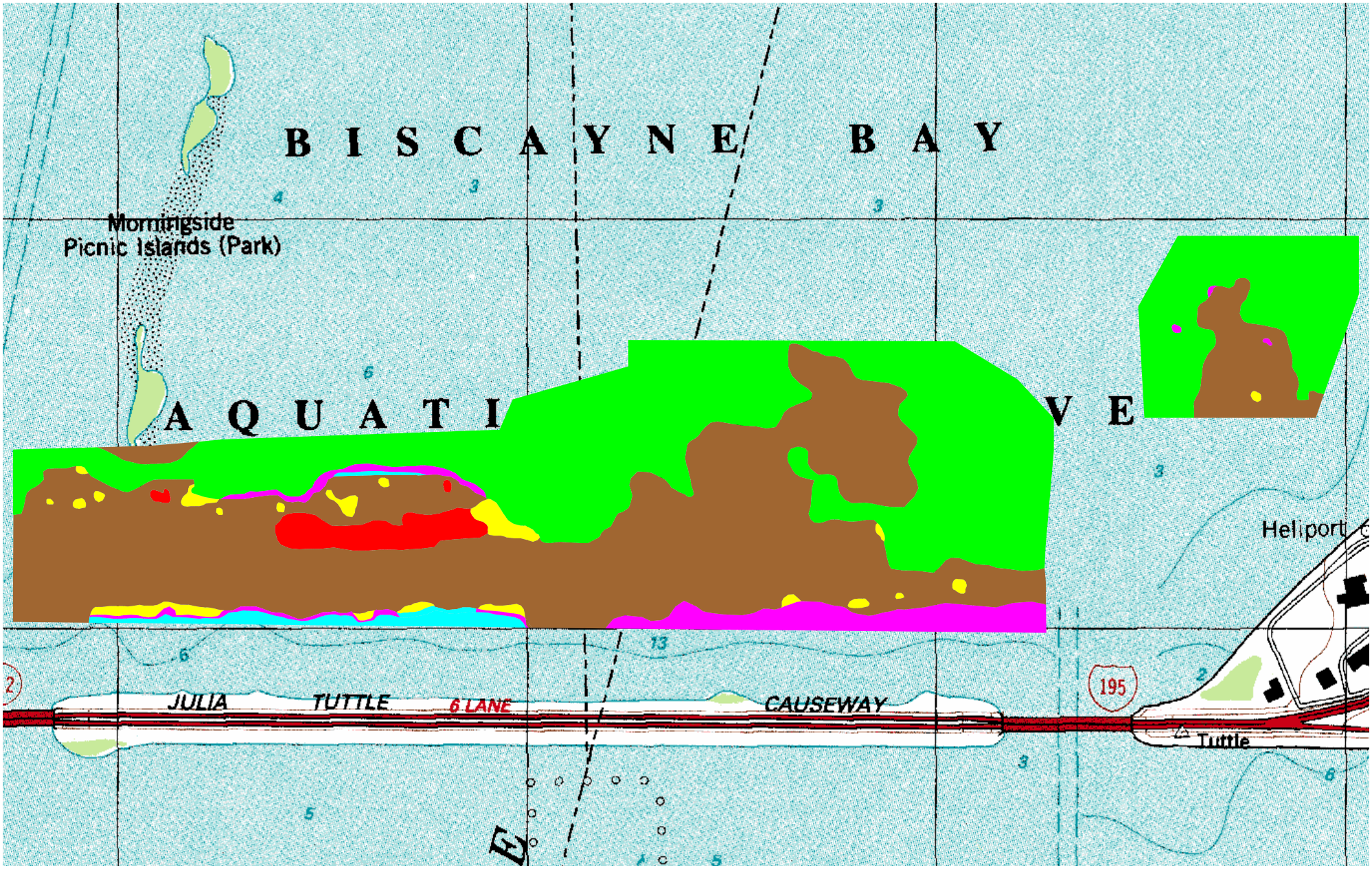
Live bottom assemblages along the walls of the borrow holes were also documented within the study area. Sponges were particularly abundant along the steep side slopes of the borrow areas as shown in Figure 7. The loggerhead sponge (*Spheciospongia vesparium*) was the most common, with some specimens reaching over 2 feet in diameter (Photograph 1, Appendix A). These live bottom areas correspond most closely with Area III-A from the Coastal Technology Corporation (1989) report. Other areas of live bottom habitat occur within the far eastern edge of the current study area (Figure 7) and do not correspond to areas identified in the previous studies.

3.1.2.2 Artificial Reef Habitat

Previously placed artificial reef material was also encountered in the deeper (>20 feet, NAVD 88) sections of the survey area (Figure 7) (Photograph 2, Appendix A). This area is close to the area identified as Area III-A by Coastal Technology (1989). This area appears to be significantly deeper than previously identified in the earlier report and now contains an artificial reef. This artificial reef material consisted of large cement pilings stacked on the bottom. No apparent growth was observed on artificial reef material.

3.1.2.3 Seagrass Distribution

Four marine seagrasses were identified during the survey. These seagrasses occurred in single and mixed species assemblages within the survey area. Marine seagrass species observed within the survey area include *H. wrightii, T. testudinum, S. filiforme,* and *Halophila*



Potential Seagrass Restoration Area Habitat Map

- Artificial Reef
- Livebottom/Hardbottom
- Syringodinum filiforme (manatee grass)
- Syringodinum filiforme (manatee grass) Mixed w/ Halophila decipiens (paddle grass), Halophila wrightii (shoal grass), and Thalassia testudinum (turtle grass)
- Mixed Halophila decipiens (paddle grass), Halophila wrightii (shoal grass), and Thalassia testudinum (turtle grass)
- Sand

1000 0 1000 2000 Feet

Marine Benthic Habitat Distribution	
Marine Survey and Assessment for Potential Mitigation Sites Miami Harbor General Re-Evaluation Report	
Scale: 1" = 1,000'	Drawn By: MR
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	Figure 7

decipiens. The endangered Johnson's seagrass (*Halophila johnsonii)* has been documented to occur within the Biscayne Bay area (Kenworthy 1997). No Johnson's seagrass was encountered during this survey. Although seagrasses occurred throughout most of the study area, the frequency of occurrence, abundance, and density varied. Of the four marine seagrass species observed, *S. filiforme* and *T. testudinum* were the most prevalent along the transects surveyed. *H. decipiens* occurred in small patches within the deeper areas along the sloping edges of the borrow holes.

Seagrass distribution is illustrated in Figure 5. The area surrounding the borrow areas was dominated by *S. filiforme* along the northern edge of the survey area (Photograph 3, Appendix A). Small patches of *H. decipens* and *H. wrightii* occur where the bottom begins to slope toward previously dredged areas along the northwestern edge of the survey area (Figure 5). Along these edges of the previously dredged areas, *S. filiforme* and *T. testudinum* become sparse and *H. decipiens* occurs. Along the southern portions of the survey area, mixed seagrasses were most prevalent. Mixed assemblages of *S. filiforme, H. wrightii, T. testudinum*, and along some of the interior deeper edges, *H. decipiens* were most common.

3.1.2.3.1 Seagrass Frequency of Occurrence, Abundance, and Density

Frequency of occurrence, abundance, and density were calculated for each seagrass species along survey transects as they occurred based on the Braun-Blanquet technique (Braun-Blanquet 1965). Quadrat samples were taken along a 60 m long transect at 0 m, 20 m, 40 m, and 60 m.

The scale values are:

0.1 = Solitary shoots with small cover
0.5 = Few shoots with small cover
1.0 = Numerous shoots but less than 5% cover
2.0 = Any number of shoots but with 5-25% cover
3.0 = Any number of shoots but with 25-50% cover
4.0 = Any number of shoots but with 50-75% cover
5.0 = Any number of shoots but with >75% cover

From the survey of quadrats along each transect, frequency of occurrence, abundance, and density of seagrass was computed as follows:

Frequency of occurrence	=	Number of occupied quadrats/total number of quadrats
Abundance	=	Sum of cover scale values/number of occupied quadrats
Density	=	Sum of cover scale values/total number of quadrats

Mean values are illustrated in Table 2.

Table 2 Mean Seagrass Frequency of Occurrence, Abundance, and Density Values for Survey Transects

Transect	Species *	Frequency	Abundance	Density
1	HD	0.11	2.00	0.50
	SF	0.69	2.25	2.25
	TT	0.02	0.10	0.03
2	HD	0.14	1.00	0.25
	SF	0.75	3.75	3.75
	TT	0.08	1.00	0.25
3	HD	0.06	1.00	0.25
	SF	0.78	2.25	2.25
	TT	0.03	0.10	0.03
4	HD	0.13	1.00	0.25
	SF	0.33	1.00	0.50
	HW	0.73	3.67	2.75
5	SF	0.95	4.50	4.50
6	SF	0.97	4.50	4.50
7	HD	0.25	4.00	1.00
	SF	0.70	2.67	2.00
	TT	0.50	3.33	2.50

Transect	Species *	Frequency	Abundance	Density
8	HW	0.25	0.05	0.03
	SF	0.53	0.70	0.53
	TT	0.75	5.00	3.75
9	HD	0.05	1.00	0.25
	HW	0.11	1.00	0.25
	SF	0.75	3.75	3.75
10	SF	0.91	4.75	4.75
11	SF	0.81	4.25	4.25
	TT	0.25	5.00	1.25
12	SF	0.86	4.25	4.25

*HW = *Halodule wrightii* SF = *Syringodium filiforme*
TT = *Thalassia testudinum* HD =*Halophila decipiens*

3.1.2.3.2 Frequency of Occurrence

Within the area surveyed, *S. filiforme* was the most frequently occurring seagrass species and the dominant cover type. Frequency of occurrence scores ranged from 0.70 to 0.97, with a mean of 0.79. In contrast, all other seagrass species had mean frequency values of less than 0.30. *T. testudinum*, *H. wrightii*, and *H. decipiens* had mean values of 0.27, 0.23, 0.12, respectively.

3.1.2.3.3 Abundance

Abundance is expressed as a sum of the cover abundance scores divided by the number of quadrats where the specific species was assigned a score. Scores range from 0 to 5, where 1.0 is less than 5 percent cover, 2.0 is 5 to 25 percent cover, 4.0 is 50 to 75 percent cover, and 5.0 is greater than 75 percent cover.

S. filiforme had the highest mean abundance within the study area (3.22). Abundance values ranged from 0.70 to 4.75 at the 12 transects where *S. filiforme* occurred. *T. testudinum* occurred within 6 transects and had a mean abundance of 2.42, while *H. wrightii* had the lowest abundance values in the survey area with a mean value of 1.57. *H. decipiens* abundance values ranged from 1.0 to 4.0 over transects where it occurred with a mean of 1.67.

3.1.2.3.4 Density

Density is expressed as the sum of the cover abundance scores divided by the total quadrats sampled. When compared to abundance values, density values can be very low because values are averaged across all quadrats within each transect, rather than only at occupied quadrats.

Across all transects sampled, *S. filiforme* had the highest density (3.12). Density values for *S. filiforme* ranged from 0.53 to 4.75. In comparison, *T. testudinum* had density values ranging from 0 to 3.75 with a mean of 1.30. *H. wrightii* and *H. decipiens* both had relatively low density values (1.00 and 0.417).

3.1.2.4 Potential Seagrass Mitigation Area Survey-Diver Reconnaissance

Diver surveys of the previously dredged borrow areas were also conducted. Divers were deployed with digital video and still cameras to document the dominant biological communities present within the deeper reaches of the borrow areas. The divers also examined the artificial reef material present within each area and documented with digital video the condition of the material. Six surficial sediment cores were also taken and archived for future examination should the need arise. The sampling locations of the sediment cores are shown on Figure 4.

Diver reconnaissance into the borrow area just south of Area III-A revealed a deep area consisting of a layer of fine silt material (Figure 7). Coastal Technology Corporation (1989) found similar habitats within these areas during the previous survey and described them as a soft mud. This area also contained a large area of artificial reef material. This artificial reef material which occupies the deeper portions of the area, is covered in this fine silt. The artificial reef has no apparent growth due to this heavy siltation. Very few fish or invertebrate species were documented on or near the artificial reefs during the survey.

Shallower portions of the borrow areas seem to have more diversity associated with them. In particular, the steep walls along the northern and southern edges of the hole south of Area III-A provide habitat for a variety of marine creatures. Loggerhead sponges, spiny lobster (*Panuliris argus*), hydroids, bryozoans, and a variety of juvenile fish species occur along these edges. Fish species observed included pinfish (*Lagodon rhomboides*), mojarra (*Euchinostomus* sp.), both juvenile and adult grunts (*Haemulon* spp.), and snappers (*Lutjanus* spp.). Also observed within the study area was a large tarpon (*Megalops atlanticus*).

3.2 Offshore Artificial Reef Areas

Two potential offshore artificial reef areas were surveyed. Hardbottom habitats were delineated using data collected from the integrated towed video survey and locations of suitable potential reef sites located. Localized areas of hardbottom habitats were located within each of the offshore areas surveyed and are shown on Figure 7 and Photograph 4 (Appendix A).

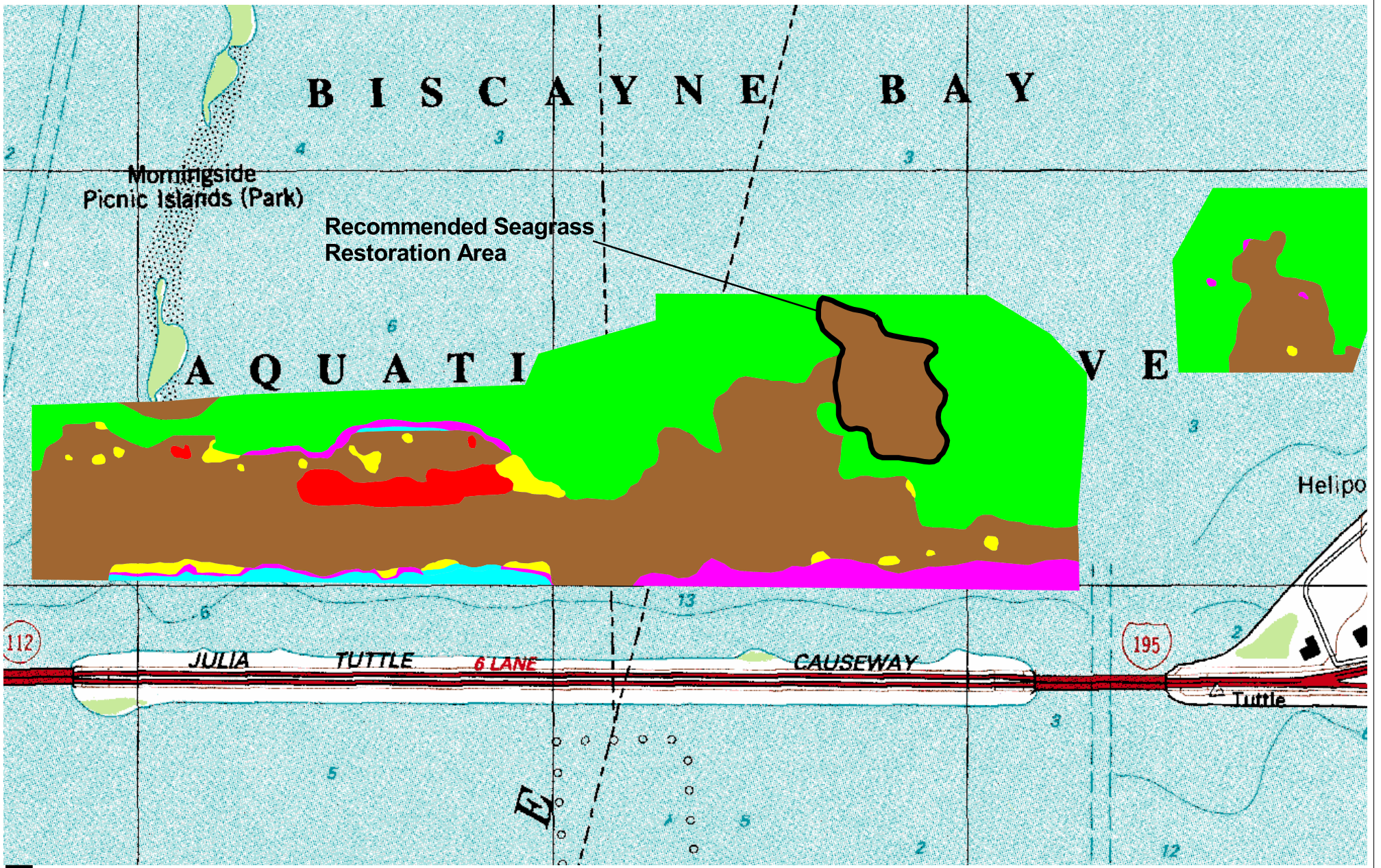
4.0 RECOMMENDATIONS

4.1 Seagrass Mitigation Areas

Coastal Technology Corporation (1989) identified three potential areas within the larger borrow area identified during this survey. Areas III-A and III-B were identified as possible mitigation areas by Coastal Technology Corporation and their results state that they may be too deep to accommodate seagrass mitigation and may be better suited for artificial reef creation. Results of this survey reveal depths even greater than identified in the previous survey. These areas may not even be suitable for artificial reef creation due to the high degree of siltation and lack of reef habitats here naturally. The artificial reef present south of Area III-A is covered in a layer of silt and has very little life associated with it; however, some small fishes and one tarpon were observed in the area.

The results of this survey and previous surveys reveal that Area III-C or similar areas in the northeastern corner of the survey area may be best suited for seagrass mitigation (Figure 8). The actual area labeled Area III-C is difficult to determine from the line drawings in the Coastal Technology Corporation report, as there are no coordinates associated with the areas identified in that report. Results of this survey reveal that a portion of the northeastern corner of the survey area has the most promise as a potential seagrass mitigation area (Figure 8). This area covers a total of 18.6 acres and has depths ranging from 4 to 8 feet (NAVD 88).

Since the survey area was most likely dominated by seagrass prior the construction of the borrow areas within this area, and continues to be bordered by dense seagrass beds to this day, successful seagrass mitigation through natural recruitment is likely. Fill material from Port expansion projects is proposed to be utilized to fill portions of these borrow areas back to ambient depths and natural seagrass recruitment will likely take place.



Recommended Seagrass Restoration Area (18.6 ac.)

Potential Seagrass Restoration Area Habitat Map

- Artificial Reef
- Livebottom/Hardbottom
- Syringodinum filiforme (manatee grass)
- Syringodinum filiforme (manatee grass) Mixed w/ Halophila decipiens (paddle grass), Halophila wrightii (shoal grass), and Thalassia testudinum (turtle grass)
- Mixed Halophila decipiens (paddle grass), Halophila wrightii (shoal grass), and Thalassia testudinum (turtle grass)
- Sand

1000 0 1000 2000 Feet

Recommended Seagrass Restoration Area	
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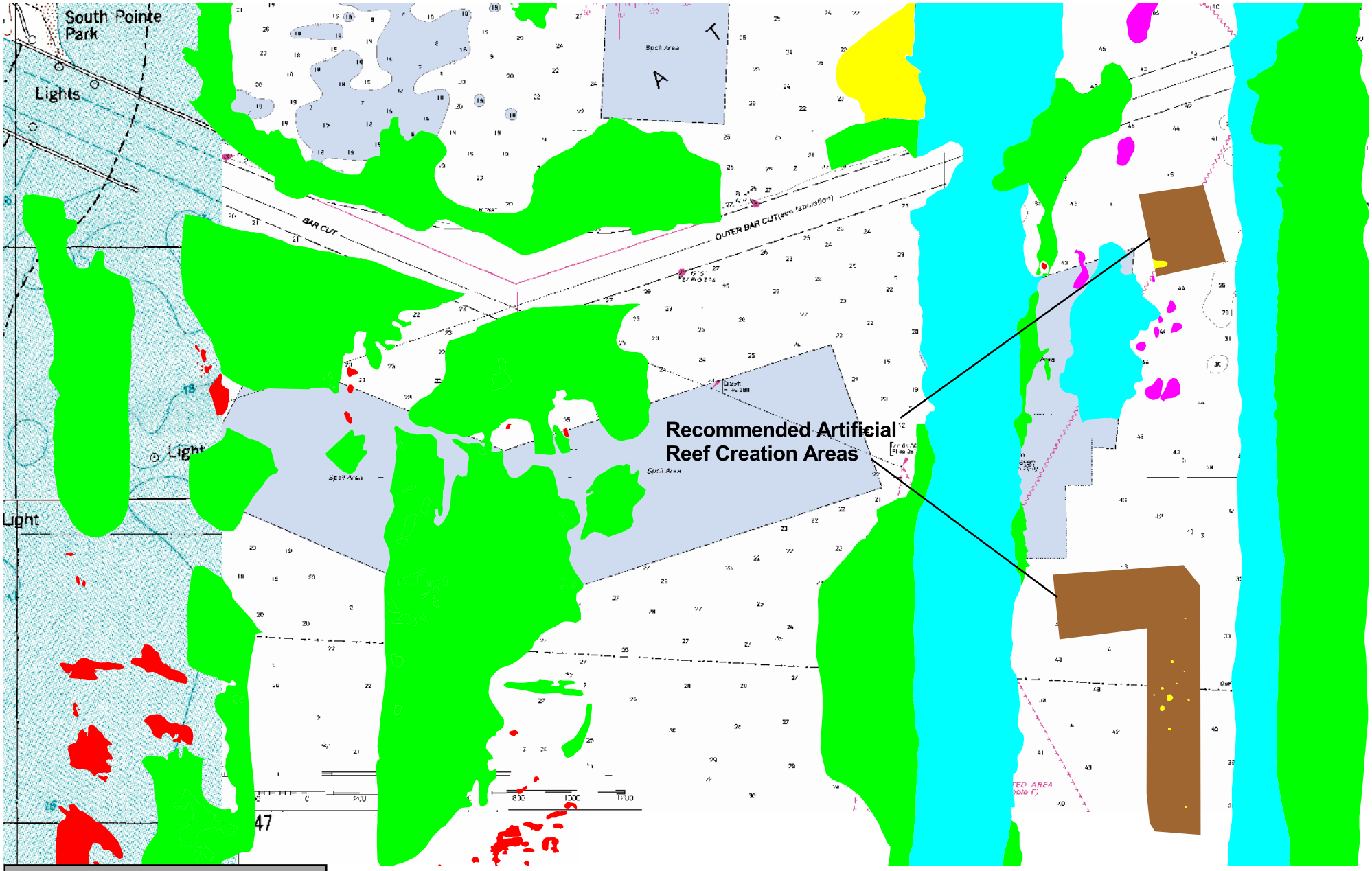
	Figure 8

4.2 Offshore Artificial Reef Areas

Results of this survey reveal two potential area of artificial reef creation offshore of Miami Harbor (Figure 9). The southern survey area adjacent to Miami-Dade County Artificial Reef Site B has the most potential with 58.3 acres available for reef creation. The relative closeness to already permitted and constructed artificial reef sites makes it a viable option. This would allow for quicker colonization of artificial reef material and allow for easy monitoring and comparison to other artificial reef projects in the area. Depths within this area are also similar to the depths impacted in the proposed future Port project (40 to 45 feet).

The northern potential reef site surveyed contains 16.3 acres of sand bottom habitat that may be used for artificial reef creation. Water depths in this area range from 35 to 40 feet. Overall, the two offshore sites surveyed contain 74.6 acres of sand bottom habitat that may be permitted for artificial reef creation.



Recommended Artificial Reef Creation Areas	
Marine Survey and Assessment for Potential Mitigation Sites Miami Harbor General Re-Evaluation Report	
Scale: 1" = 1,500'	Drawn By: MR
Date: July, 2002	
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	Figure 9

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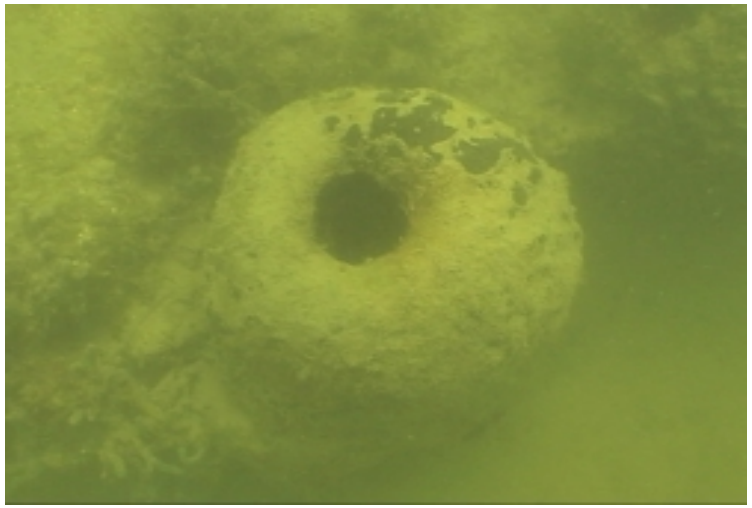
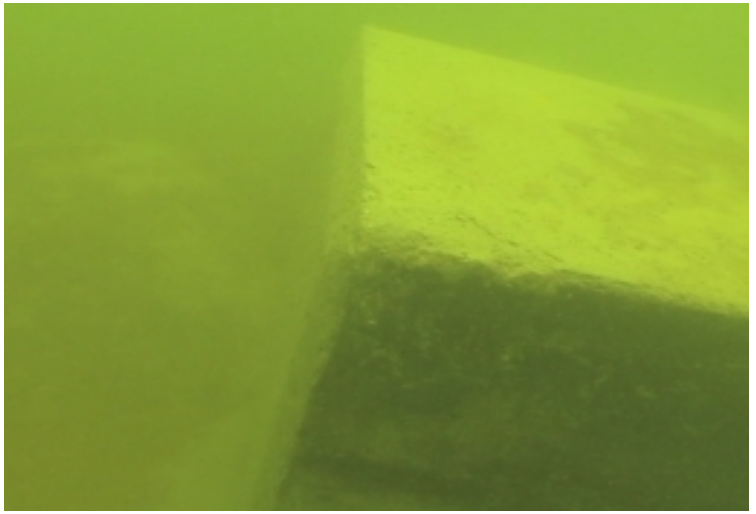
APPENDIX A

Photographs



Photograph 1. Large sponge along southern wall of previously dredged borrow areas along the Julia Tuttle Causeway.



Photograph 2. Artificial reef material placed in previously dredged borrow areas . Reef material showed no living growth and was covered in a fine silt.

Photograph 3. Towed video captured image showing dense *Syringodium filiforme* along edge of previous borrow area.

Photograph 4. Hardbottom habitat present within potential offshore mitigation areas.